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# National Transportation Safety Board

Washington, D.C. 20594  
**Safety Recommendation**

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Date: May 10, 1988

In reply refer to: H-88-16 through -20

Mr. Robert C. Farris  
Acting Administrator  
Federal Highway Administration  
Washington, D.C. 20590

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On April 5, 1987, two spans of a 540-foot-long New York State Thruway (I-90) bridge over the Schoharie Creek fell about 80 feet into the rain-swollen creek after pier 3, which partially supported the spans, collapsed. Ninety minutes after the initial collapse, pier 2 and a third span collapsed. Four passenger cars and one tractor-semitrailer plunged into the creek, and 10 persons were fatally injured. Water levels in the creek had been rising since the afternoon of April 4 and the National Weather Service had issued warnings of flooding in the low-lying areas adjacent to the creek. 1/

After the flood, when the bridge wreckage was removed and the loose sand and silt were excavated from around pier 3, scour was noted around piers 2 and 3. The Safety Board contracted with Resource Consultants, Inc. (RCI) and Colorado State University (CSU) in Fort Collins, Colorado, to study the role of scour in the bridge collapse. This study was co-sponsored by the New York State Thruway Authority (NYSTA). RCI and CSU conducted on-site examinations, collected hydraulic data, developed flood hydrographs, performed a hydraulic water-surface profile computer analysis (WSPRO), constructed two- and three-dimensional physical models, and evaluated riprap stability based on the combined analyses. The study included a comparison of the characteristics of the 1987 flood with the flood of record, which occurred in 1955, because, although the 1955 flood had both greater peak flow and volume, the bridge survived it with little noted damage.

1/ For more information, read Highway Accident Report--"Collapse of New York State Thruway Bridge over the Schoharie Creek, Amsterdam, New York, April 5, 1987" (NTSB/HAR-88/02).

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The RCI/CSU study also addressed the magnitude of water velocity that would move rocks of given sizes. The RCI/CSU study concluded that the velocities and turbulence around piers 2 and 3 at the bridge site were large enough to remove the 300-pound riprap specified in the design of the bridge. Because the velocities and turbulence around pier 3 were much larger than around pier 2 (due to the bend in the river upstream), riprap could be removed much faster from around pier 3 than pier 2. RCI/CSU concluded that each flow with a peak discharge greater than 30,000 cfs had the potential for removing some of the riprap around pier 2.

Based on the magnitude of their flows, their direction, and their similarities in velocity, the floods of 1955 and 1987 had similar erosion capability. The Safety Board thus concludes that had the piers been protected by riprap at the time of the April 1987 flood as they were during the 1955 flood, the bridge probably would not have collapsed.

Currently, several programs on scour research are underway both at the State and Federal level. The purpose of these programs is to evaluate the performance of bridge foundations during floods, to develop more reliable and accurate scour prediction equations, and to identify design changes that will improve bridge stability during floods. In addition, the Federal Highway Administration (FHWA) plans to issue a technical advisory on scour during the summer of 1988. The Safety Board is encouraged by the Federal-State cooperative scour research program currently being implemented in several States. <sup>2/</sup> This cooperative effort can minimize the level of duplication among agencies and the time required to complete this important research. The Safety Board believes that because current methods for estimating stream velocities result in a wide range in the size of riprap that may move at a given velocity and predicting scour depth are more of an art than a science, continued research is needed to improve present methods for determining the potential for scour and movement of riprap at selected bridge sites.

The Safety Board's investigation of the collapse of the Chickasawbogue Bridge <sup>3/</sup> revealed that many States were not performing underwater inspections of their bridges. Further, the inspections performed by some of those States that were performing underwater inspections were not sufficiently thorough. As a result of the Chickasawbogue accident, the Safety Board on June 17, 1986, recommended that the FHWA:

<sup>2/</sup> Virginia, Maryland, Delaware, Arkansas, New York, Oregon, Ohio, Connecticut, Pennsylvania, and California.

<sup>3/</sup> For more information, read Highway Accident Report--"Collapse of the U.S. 43 Chickasawbogue Bridge Spans Near Mobile, Alabama, April 24, 1985" (NTSB/HAR-86/01).

H-86-3

Establish criteria for inspecting the underwater elements of bridges which consider the following factors as they relate to bridge design and maintenance:

Complexity of structure and materials used,  
Marine environment surrounding the underwater elements of the bridges, and  
Frequency and magnitude of loads on the bridges.

In response to this recommendation, the FHWA informed the Safety Board that it was preparing a Notice of Proposed Rulemaking (NPRM) to revise the National Bridge Inspection Standards (NBIS) for underwater inspections to address the safety issues listed. (The NPRM was subsequently published in April 1987.) Based on this action, recommendation H-86-3 has been classified "Open-Acceptable Action" pending revision to the NBIS to meet the intent of this recommendation.

The April 1987 NPRM proposes that States identify and maintain a master list of bridges with underwater members that cannot be evaluated visually during low tide or by touch. The NPRM also proposes that underwater inspections be conducted at least every 5 years. The Safety Board commented on the NPRM to FHWA, stating that the proposed regulations do not adequately respond to its prior recommendation that the FHWA establish specific criteria for comprehensive underwater inspections of bridges.

The frequency and extent of underwater inspections should be based on such factors as the characteristics of the stream channel, the velocity of the stream, the propensity of the stream to flooding, the type of footing, and the type of structure. If a stream has a history of turbulent flow, as does the Schoharie Creek, and if the bridge is built on piers with shallow spread footings protected by riprap, more frequent and thorough underwater inspections are required than for a bridge with piers in placid water or on footings set very deep beneath the streambed and on piles.

Specific criteria for underwater inspections should be established within the NBIS, based on these factors, and not left to the discretion of State highway officials. This will help to ensure that the inspections are comprehensive and frequent enough to account for the complexity of the bridge substructure and foundation, and for its environment. In addition, such criteria will promote uniformity among the States in conducting their underwater inspections. The Safety Board believes that the inadequate guidance and replacement of riprap provided to the NYSTA inspectors resulted, in part, from the lack of specific guidance available at the time from the FHWA or the American

Association of State Highway and Transportation Officials (AASHTO). Improved guidance for inspectors is needed on what constitutes sufficient deterioration of scour protection (such as riprap) or of the foundation to require that repairs be made. Finally, the NBIS should be expanded to improve guidance on how to inspect other underwater elements, such as scour piles and sheeting.

The Safety Board believes that the circumstances that led to the collapse of the Schoharie Creek Bridge were not isolated events but may represent conditions that can occur at other bridge sites throughout the country. Because the general design of the collapsed bridge was similar to the design of many bridges constructed in the late 1940s through 1960s, there is a potential for other similarly designed and constructed bridges to collapse catastrophically from erosion of their foundations.

In an attempt to try to quantify the magnitude of this problem, the Safety Board requested the FHWA to determine the number of bridges nationwide over water that are similar to the collapsed Schoharie Creek Bridge. The FHWA responded that it could not provide this data. However, the Safety Board was able to obtain such data from three States (Minnesota, New York, and Virginia) which, as a result of the Schoharie Creek Bridge collapse or other recent floods within the States, had performed data searches. Consequently, several hundred bridges over water with spread footings and nonredundant structural features were identified and inspected, and at least 25 bridges (15 after the inspection) were closed, pending repair.

The Safety Board believes that the search initiated within the three States should be extended to States that have not made such a search, particularly in light of a 1987 FHWA survey, which indicated that at least 43,000 bridges nationwide have not been inspected within the last 2 years. More importantly, it is still not clear whether the bridges that have been inspected have received comprehensive underwater inspections. In view of this, the Safety Board believes that the FHWA should require the States to review their bridge inventory data, identify bridges similar to the Schoharie Creek Bridge, and conduct underwater inspections of these bridges as needed.

In 1978, the New York State Department of Transportation (NYSDOT) recognized that the NYSTA and other public entities did not meet all the requirements of the NBIS, which were extended by the Federal Surface Transportation Assistance Act of 1978 to include all bridges carrying traffic on public roads (off-system bridges). To meet the Federal requirements, the NYSDOT had to inventory 12,000 to 13,000 off-system bridges. Because of the immense workload required by the new regulations, the NYSDOT hired consultants to inspect many of the Thruway bridges. These inspections (which included the Schoharie Creek Bridge) were a one-time effort by the NYSDOT to comply initially with the inventory requirements of the 1978 Act.

Despite the NYSDOT effort to comply with the NBIS by hiring consulting engineers to inspect bridges, the information that they obtained was used primarily to satisfy the inventory requirements of the NBIS without analyzing or otherwise using the results. Thus, the Safety Board concludes that the NYSDOT lost an opportunity to learn about the missing riprap at the Schoharie Creek Bridge and to alert the NYSTA to correct the situation.

At the time of the collapse, the NYSDOT was developing criteria and methods for performing underwater inspections. They had established a list of bridges that were to receive an underwater inspection and the Schoharie Creek Bridge was on the list. However, the issuance of a contract for the underwater inspections was delayed because, according to the NYSDOT, New York State's share of Federal highway funds was exhausted. Apparently, no NYSDOT official ever notified NYSTA officials of the delay and the NYSTA took no other action. In the meantime, the Schoharie Creek Bridge collapsed.

The Safety Board believes that a proper underwater inspection of the Schoharie Creek Bridge piers before their collapse may have uncovered a lack of adequate riprap or other manifestations of scour, such as a scour hole in the streambed. Such additional evidence of scour may have sufficiently motivated the NYSTA to replace the missing riprap.

As a result of its investigation of the Mianus River Bridge collapse, <sup>4/</sup> the Safety Board recommended on July 19, 1984, that the U.S. Department of Transportation (DOT):

H-84-56

Direct the DOT Inspector General to review the Federal Highway Administrator's bridge inspection audit program for its sufficiency in establishing State compliance with the National Bridge Inspection Standards.

The DOT responded that Inspector General audits of FHWA bridge programs had been expanded to include bridge inspection, and that the Inspector General's office would review the effectiveness of the FHWA in obtaining compliance with the NBIS. As a result of this action, recommendation H-84-56 has been classified "Closed--Acceptable Action."

On May 15, 1987, the DOT, Office of Inspector General, Region 3 forwarded copies of a final report on the audit of the Quality of Bridge Inspection to the FHWA Region 1 Administrator. The audit had been conducted at the Region 1 Office, various FHWA division offices, and State Highway Agency Offices in three Region 1 States -- New York, New Jersey, and Vermont.

<sup>4/</sup> For more information, read Highway Accident Report--"Collapse of a Suspended Span of Interstate Route 95 Highway Bridge Over the Mianus River, Greenwich, Connecticut, June 28, 1983" (NTSB/HAR-84/03).

The results of this audit indicated that management of the bridge inspection programs in FHWA Region 1 needed improvement because full compliance with the NBIS in Region 1 had never been achieved during the preceding 15 years. Among other deficiencies, the audit indicated that before June 1985, the FHWA had not emphasized underwater inspections and had not required the FHWA divisions to review the States' underwater inspection capabilities. Following an FHWA directive of June 26, 1985, on NBIS underwater inspections, the audit indicated that the three States had performed underwater inspections on selected bridges but had not established formal comprehensive programs to identify all bridges requiring an underwater inspection. In New York, only 2 of the 11 transportation regions in the State had performed any underwater inspections.

Although the audit report made no recommendations concerning underwater inspections, it concluded that the Region 1 bridge inspection program was below standard primarily because the region had not required the States to allocate sufficient resources to bridge inspection programs and to the development of capable inspection organizations. Further, Region 1 had not taken aggressive action, such as the temporary suspension of Federal aid to encourage the States to comply with NBIS.

FHWA data indicate that 6 percent of all bridges in New York State were overdue for inspection in 1986 and 1987. However, the FHWA was already aware that the NYSTA was not inspecting its bridges within the time specified by the NBIS. In its 1986 review of the New York State Bridge Program, the FHWA New York division office pointed out that of the approximately 250 bridges that the NYSTA needed to inspect, 50 percent had not been inspected within the last 2 years. In addition, the below-water substructural components of several of these bridges, including the Schoharie Creek Bridge, had never been inspected.

On January 27, 1988, the DOT Office of the Inspector General informed the Safety Board that it had completed an audit of the FHWA National Bridge Inspection Program (NBIP) for the period from January 1984 through June 1986. The objectives of the audit were to evaluate the adequacy of the States' programs for conducting bridge inspections and the FHWA's controls for managing the NBIP. They found weaknesses in the bridge inspection programs of the seven States 5/ audited, including New York State. The audit, which included information from the Region 1 audit previously mentioned, showed that States had not performed underwater inspections, established adequate internal controls, or conducted thorough inspections. While the FHWA has acted to strengthen its controls for managing the NBIP, the Office of the Inspector General found that the FHWA had not adequately (1) monitored essential elements of the States' bridge

5/ New York, New Jersey, Vermont, Florida, South Carolina, Louisiana, and Arkansas.

inspection programs, (2) ensured that States provided written responses indicating the corrective action taken on identified deficiencies, and (3) evaluated the FHWA divisions' monitoring of the States' bridge inspection programs. Further, the Office of Inspector General found that these conditions existed because (1) standards and other criteria did not clearly require the State to perform underwater inspections and establish internal controls over bridge inspections, (2) States did not have the proper equipment available for making inspections, (3) States were not required to document corrective actions taken on deficiencies reported by bridge inspectors, (4) States had not allocated sufficient resources to the bridge inspection program, and (5) the FHWA had not established sufficient control for monitoring the States' bridge inspection programs.

Based on its prior investigations of bridge accidents and on the DOT Office of Inspector General's findings and recommendations, the Safety Board concludes that, as an agency, the FHWA has lacked aggressiveness and initiative in formulating and implementing a comprehensive bridge inspection program among the States. Moreover, the FHWA has been particularly slow to encourage the States to adopt comprehensive underwater inspection programs and to provide guidance on the proper inspection techniques and procedures that should be employed.

With regard to the State of New York, the Safety Board believes that despite the distinct institutional difference between the NYSDOT and the NYSTA, the FHWA should have required the NYSDOT to ensure that all bridges on public roads were inspected in accordance with the NBIS, including the bridges on the Thruway, or it should have withheld Federal aid pending the NYSDOT's acceptance of its responsibility. As the matter stood, NYSTA's inadequate inspections, although reported to the NYSDOT, were never carefully scrutinized to detect and correct the inadequacies.

The Safety Board recognizes that the FHWA has had difficulty in the past in obtaining State compliance with the NBIS and with the development of programs to provide adequate guidance on inspection techniques and procedures. Consequently, the Safety Board believes that the FHWA should more aggressively withhold Federal funds, if necessary, from the States if owners of public bridges do not comply with the NBIS.

In this accident, New York State Police traveled over the bridge about 5 minutes before its collapse and did not notice anything unusual about the bridge or its riding surface. Since the State Police did not have a way to determine the condition of the bridge or the danger that was imposed by the flood, the bridge was not closed.

Since it is unlikely that monitoring teams will be available at all bridges during flooding if and when devices such as truck-mounted fathometers are fully developed, other warning systems need to be developed. The Safety Board believes that the FHWA should perform research on simpler methods that could provide a warning of the extent of scour or the severity of flooding at bridges over water, especially for those supported by spread footings.

Therefore, the National Transportation Safety Board reiterates Safety Recommendation H-86-3 and also recommends that the Federal Highway Administration:

Expand the scope of the Federal-State cooperative research program on evaluating bridge performance during flood conditions to include the documentation and analysis of riprap stability at applicable bridge sites; disseminate the results of this expanded study to owners of bridges. (Class II, Priority Action) (H-88-16)

Encourage States to conduct in-depth hydraulic studies during rehabilitation and reconstruction of bridges over water to determine if changes in the stream flow and streambed have affected the adequacy of the initial design. (Class II, Priority Action) (H-88-17)

Require all States that have not done so within the last year to conduct underwater inspections of all their bridges founded on spread footings for evidence of scour (such as movement of riprap, development of scour holes in the streambed, and changes in the streambed material composition), placing priority on those bridges with nonredundant designs. (Class I, Urgent Action) (H-88-18)

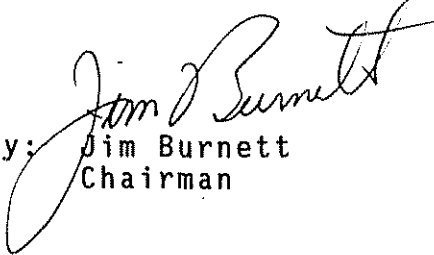
Compel, by withholding Federal funds if necessary, the owners of all public bridges including those not owned by the States, to comply with the National Bridge Inspection Standards. (Class II, Priority Action) (H-88-19)

Research methods by which alerting signs and detection devices could be placed on or near bridges for observation during flood conditions to aid in the decision to close bridges, particularly those built on spread footings. (Class II, Priority Action) (H-88-20)

The Safety Board also issued Safety Recommendations H-88-12 through -15 to the American Association of State Highway and Transportation Officials; H-88-21 to the U.S. Department of Transportation; H-88-22 to the New York State Department of Transportation; and H-88-23 to the American Association of State Highway and Transportation Officials, International Bridge, Tunnel and Turnpike Association, National Associations of Counties, National League of Cities, and the National Association of Towns and Townships.



BURNETT, Chairman, KOLSTAD, Vice Chairman, and LAUBER and NALL, Members, concurred in these recommendations.

  
By: Jim Burnett  
Chairman

